EXHIBIT B

AO 440 (Del Rev. 10/01) Summons in a Civil Action

United States District Court

District of DELAWARE

LG.PHILIPS, INC.,

Plaintiff,

v.

TATUNG COMPANY, TATUNG COMPANY OF AMERICA, INC., CHUNGHWA PICTURE TUBES, LTD., and VIEWSONIC CORPORATION,

Defendants.

SUMMONS IN A CIVIL CASE

CASE NUMBER: 05-292

TO: Tatung Company
c/o Secretary of State of the State of Delaware
John G. Townsend Building, Duke of York Street
Dover, DE 19901

YOU ARE HEREBY SUMMONED and required to serve upon PLAINTIFF'S ATTORNEY (name and address)

Richard D. Kirk, Esq.
The Bayard Firm
222 Delaware Avenue, Suite 900
Wilmington, Delaware 19801
302-655-5000 (phone)
302-658-6395 (fax)

an answer to the complaint which is hereby served upon you, within 20 days after service of this summons upon you, exclusive of the day of service. If you fail to do so, judgment by default will be taken against you for the relief demanded in the complaint. An answer that you serve on the parties to this action must be filed with the Clerk of this Court within a reasonable period of time after service.

PETER T. DALLEO
CLERK

MAY 16 2005
DATE

(By) DEPUTY CLERK

585500v1

AO 440 (Rev. 8/01) Summons in a Civil Action

RETURN OF SERVICE

Service of the Summons and Complaint was made by me[1]	DATE 5/17/05
NAME OF SERVER (*PRINT*) ED JONES	TITLE PROCESS SERVER

Check one box below to indicate appropriate method of service

☒ Served personally upon the defendant. Place where served: SECRETARY OF STATE 401 FEDERAL ST, DOVER DE 19901 ~~AT~~ SERVICE WAS ACCEPTED BY PEARL JOHNSON AT 9:42 A.M.

☐ Left copies thereof at the defendant's dwelling house or usual place of abode with a person of suitable age and discretion then residing therein.

Name of person with whom the summons and complaint were left: _____

☐ Returned unexecuted: _____

☐ Other (specify): _____

STATEMENT OF SERVICE FEES

TRAVEL	SERVICES	TOTAL

DECLARATION OF SERVER

I declare under penalty of perjury under the laws of the United States of America that the foregoing information contained in the Return of Service and Statement of Service Fees is true and correct.

Executed on 5/17/05
Date

Signature of Server

32 W. LOOCKERMAN ST DOVER, DE 19901
Address of Server

[1] As to who may serve a summons see Rule 4 of the Federal Rules of Civil Procedure.

IN THE UNITED STATES DISTRICT COURT

FOR THE DISTRICT OF DELAWARE

LG.PHILIPS LCD CO., LTD., Plaintiff, v. TATUNG COMPANY; TATUNG COMPANY OF AMERICA, INC.; CHUNGHWA PICTURE TUBES, LTD.; AND VIEWSONIC CORPORATION, Defendants.	Civil Action No. _____ DEMAND FOR TRIAL BY JURY

COMPLAINT FOR PATENT INFRINGEMENT

Plaintiff LG.Philips LCD Co., Ltd. ("LPL") for its Complaint against Defendants Tatung Company; Tatung Company of America, Inc.; Chunghwa Picture Tubes, Ltd.; and ViewSonic Corporation (collectively the "Defendants") for preliminary and permanent injunctive and declaratory relief and for damages, including treble or multiple damages, for patent infringement, states and alleges as follows:

NATURE OF THE ACTION

1. LPL is the owner of United States Patent No. 6,738,121 ("the '121 Patent") and United States Patent No. 5,019,002 ("the '002 Patent") (collectively the "Patents-in-Suit"). This is a civil action for the infringement of the Patents-in-Suit, including the willful infringement of the Patents-in-Suit by Defendants.

2. The technology at issue involves the design and manufacture of Liquid Crystal Display modules ("LCDs"), which are a type of flat panel display that are incorporated into at least LCD portable computers, LCD computer monitors and LCD televisions.

THE PARTIES

3. Plaintiff LPL is a corporation organized under the laws of the Republic of Korea, having a place of business located in Seoul, Korea.

4. Defendant Tatung Company ("Tatung") is a Taiwanese corporation, having a place of business at 22 Chungshan N Rd. Section 3, Taipei, Taiwan.

5. Defendant Tatung Company of America, Inc. ("Tatung America") is a subsidiary of Tatung. Tatung America is a California corporation, having a place of business at 2850 El Presidio Street, Long Beach, California 90810. Tatung America markets and sells Tatung's products throughout the United States.

6. Defendant Chunghwa Picture Tubes, Ltd. ("CPT") is a subsidiary and/or affiliate of Tatung. CPT is a Taiwanese corporation, having a place of business at No. 1127, Ho-ping Road, Tanan, Pahte, Taoyuan, Taiwan.

7. Defendant ViewSonic Corporation ("ViewSonic") is a Delaware Corporation, having a place of business at 381 Brea Canyon Road, Walnut, California 91789.

JURISDICTION AND VENUE

8. This action is based upon and arises under the Patent Laws of the United States, 35 U.S.C. § 100 *et seq.*, and in particular §§ 271, 281, 283, 284 and 285, and is intended to redress infringement of the Patents-in-Suit owned by LPL.

9. This Court has jurisdiction over the subject matter of this action pursuant to 28 U.S.C. §§ 1331 and 1338(a).

10. Defendants have transacted and continue to transact business in the United States and in this judicial district by: using or causing to be used; making; importing or causing to be imported; offering to sell or causing to be offered for sale; and/or selling or causing to be sold directly, through intermediaries and/or as an intermediary, a variety of products that infringe the Patents-in-Suit to customers in the United States, including customers in this judicial district, and Defendants will continue to do so unless enjoined by this Court.

11. This Court has personal jurisdiction over Tatung and CPT, and venue is proper in this judicial district pursuant to 28 U.S.C. §§ 1391 (b) and (c) and (d), and 28 U.S.C. § 1400(b), in that these Defendants are committing and are causing acts of patent infringement within the United States and within this judicial district, including the infringing acts alleged herein, both directly, through one or more intermediaries, and as an intermediary, and in that these Defendants have caused and cause injury and damages in this judicial district by acts or omissions outside of this judicial district, including but not limited to utilization of their own distribution channels established in the United States and Tatung America's distribution channels in the United States, as set forth below, to ship a variety of products that infringe the Patents-in-Suit into the United States and into this judicial district while deriving substantial revenue from services or things used or consumed within this judicial district, and will continue to do so unless enjoined by this Court.

12. This Court has personal jurisdiction over Tatung America and venue is proper in this judicial district pursuant to 28 U.S.C. §§ 1391 (b) and (c), and 28 U.S.C. § 1400(b), in that Tatung America is committing acts of patent infringement within the United States and within

this judicial district, including the infringing acts alleged herein, both directly, through one or more intermediaries, and as an intermediary. Tatung America regularly imports large quantities of Tatung LCD products into the United States for distribution throughout the United States, including in this judicial district. Tatung America is intimately involved in the distribution of infringing LCD products and is acutely aware that its products are sold throughout the United States, including in Delaware. Tatung's and Tatung America's established distribution networks consist of numerous national distributors and resellers, and Tatung and Tatung America distribute to national retailers that have stores located in Delaware. By shipping into, offering to sell in, using, or selling products that infringe the Patents-in-Suit in this judicial district, or by inducing or causing those acts to occur, Tatung America has transacted and transacts business and performs works and services in this judicial district, has contracted and contracts to supply services and things in this judicial district, has caused and causes injury and damages in this judicial district by acts and omissions in this judicial district, and has caused and causes injury and damages in this judicial district by acts or omissions outside of this judicial district while deriving substantial revenue from services or things used or consumed within this judicial district, and will continue to do so unless enjoined by this Court.

13. This Court has personal jurisdiction over ViewSonic, and venue is proper in this judicial district pursuant to 28 U.S.C. §§ 1391 (b) and (c), and 28 U.S.C. § 1400(b), in that ViewSonic is incorporated and therefore resides in Delaware for purposes of establishing venue in this district, in that ViewSonic has been doing business in Delaware, including the infringing acts alleged herein, both directly, through one or more intermediaries, and/or as an intermediary, and will continue to do so unless enjoined by this Court.

THE PATENTS-IN-SUIT

14. On May 18, 2004, the '121 Patent, entitled "Tape Carrier Package with Dummy Bending Part and Liquid Crystal Display Employing the Same," was duly and legally issued, listing LPL as assignee. A copy of the '121 Patent is attached as Exhibit A.

15. On May 28, 1991, the '002 Patent, entitled "Method of Manufacturing Flat Panel Backplanes including Electrostatic Discharge Prevention and Displays Made Thereby," was duly and legally issued, listing LPL as assignee. A copy of the '002 Patent is attached as Exhibit B.

16. LPL owns the Patents-in-Suit and possesses the right to sue and to recover for infringement of the Patents-in-Suit.

17. Defendants have been and are infringing, contributorily infringing and/or actively inducing infringement of the Patents-in-Suit because they at least use, cause to be used, make, import, cause to be imported, offer for sale, cause to be offered for sale, sell, and/or cause to be sold in this judicial district and elsewhere in the United States products that infringe the Patents-in-Suit.

FACTUAL BACKGROUND

18. LPL has invested substantial time and money in designing, developing, manufacturing and producing LCD products that incorporate the patented LCD technology.

19. LPL derives substantial benefits from the exploitation of its patented technology in the United States and abroad. LPL's interests, including, but not limited to, these benefits have been and continue to be harmed by the Defendants' infringement of the Patents-in-Suit.

20. The Defendants at least use, cause to be used, make, import, cause to be imported, offer for sale, cause to be offered for sale, sell, and/or cause to be sold in the United States and in

this judicial district LCDs and/or LCD products and other electronic devices that are encompassed by and/or made by the methods claimed in the Patents-in-Suit.

21. The Defendants have actively induced and continue to actively induce the infringement of the Patents-in-Suit in the United States and in this judicial district. Defendants have engaged in active inducement by, *inter alia*, publishing and releasing engineering specifications in English for their infringing monitors and/or televisions; providing technical assistance to their resellers and customers in the United States; and marketing and distributing their infringing monitors and/or televisions through established distribution channels with knowledge of their intended sale and use in the United States, including in this judicial district.

COUNT I
(PATENT INFRINGEMENT BY DEFENDANTS TATUNG, TATUNG AMERICA, CPT, AND VIEWSONIC OF THE '121 PATENT)

22. The allegations in the foregoing paragraphs of this Complaint are incorporated by reference herein as if restated and set forth in full.

23. Defendants have infringed, actively induced and/or contributed to the infringement of the '121 Patent by making, using, causing to be used, offering to sell, causing to be offered for sale, selling, causing to be sold, importing, and/or causing to be imported products that infringe one or more claims of the '121 Patent in this judicial district and elsewhere in the United States. Such infringing products include at least the product identified as a Tatung monitor L17AMTN offered for sale and sold by at least Best Buy to a customer in Delaware; and include at least the product identified as a ViewSonic monitor ES710 offered for sale and sold by at least CompUSA to a customer in Delaware; as well as products that infringe the '121 Patent that are not yet identified.

24. The infringing products that are made, used, caused to be used, sold, caused to be sold, offered for sale, caused to be offered for sale, imported, and/or caused to be imported by Defendants meet each and every limitation of at least one claim of the '121 Patent, either literally or equivalently.

25. LPL has been and will continue to be injured by Defendants' past and continuing infringement of the '121 Patent and is without adequate remedy at law.

26. Defendants have, upon information and belief, infringed and are infringing the '121 Patent with knowledge of LPL's patent rights and without a reasonable basis for believing their conduct is lawful. Defendants' infringement has been and continues to be willful and deliberate, and will continue unless enjoined by this Court, making this an exceptional case and entitling LPL to increased damages and reasonable attorneys' fees pursuant to 35 U.S.C. §§ 284 and 285.

COUNT II
(PATENT INFRINGEMENT BY DEFENDANTS TATUNG, TATUNG AMERICA, CPT, AND VIEWSONIC OF THE '002 PATENT)

27. The allegations in the foregoing paragraphs of this Complaint are incorporated by reference herein as if restated and set forth in full.

28. Defendants have infringed, actively induced and/or contributed to the infringement of the '002 Patent by making, using, causing to be used, offering to sell, causing to be offered for sale, selling, causing to be sold, importing, and/or causing to be imported products that are made by a method that infringe one or more claims of the '002 Patent in this judicial district and elsewhere in the United States. Such infringing products include at least the product identified as a Tatung monitor L17AMTN offered for sale and sold by at least Best Buy to a

customer in Delaware; and include at least the product identified as a ViewSonic monitor ES710 offered for sale and sold by at least CompUSA to a customer in Delaware; as well as products that infringe the '121 Patent that are not yet identified.

29. The products made by the infringing method that are used, caused to be used, sold, caused to be sold, offered for sale, caused to be offered for sale, imported, and/or caused to be imported by Defendants meet each and every limitation of at least one claim of the '002 Patent, either literally or equivalently.

30. LPL has been and will continue to be injured by Defendants' past and continuing infringement of the '002 Patent and is without adequate remedy at law.

31. Defendants have, upon information and belief, infringed and are infringing the '002 Patent with knowledge of LPL's patent rights and without a reasonable basis for believing their conduct is lawful. Defendants' infringement has been and continues to be willful and deliberate, and will continue unless enjoined by this Court, making this an exceptional case and entitling LPL to increased damages and reasonable attorneys' fees pursuant to 35 U.S.C. §§ 284 and 285.

PRAYER FOR RELIEF

WHEREFORE, Plaintiff LPL prays for judgment as follows:

A. That Tatung, Tatung America, CPT, and ViewSonic have infringed the Patents-in-Suit;

B. That Tatung's, Tatung America's, CPT's, and ViewSonic's infringement of the Patents-in-Suit has been willful.

C. That Tatung, Tatung America, CPT, and ViewSonic and their parents, subsidiaries, affiliates, successors, predecessors, assigns, and the officers, directors, agents, servants and employees of each of the foregoing, and those persons acting in concert or participation with any of them, are preliminarily and permanently enjoined and restrained from continued infringement, including but not limited to using, making, importing, offering for sale and/or selling products that infringe, and from contributory infringement and from inducing the infringement of, the Patents-in-Suit, prior to the expiration of the Patents-in-Suit, including any extensions;

D. That Tatung, Tatung America, CPT, and ViewSonic and their parents, subsidiaries, affiliates, successors, predecessors, assigns, and the officers, directors, agents, servants and employees of each of the foregoing, and those persons acting in concert or participation with any of them deliver to LPL all products that infringe, or induce or contribute to the infringement of the Patents-in-Suit for destruction at LPL's option;

E. That LPL be awarded monetary relief adequate to compensate LPL for Tatung's, Tatung America's, CPT's, and ViewSonic's acts of infringement of the Patents-in-Suit within the United States prior to the expiration of the Patents-in-Suit, including any extensions;

F. That any monetary relief awarded to LPL regarding the infringement of the Patents-in-Suit by Defendants be trebled due to the willful nature of Tatung's, Tatung America's, CPT's, and ViewSonic's infringement of the Patents-in-Suit;

G. That any monetary relief awarded to LPL be awarded with prejudgment interest;

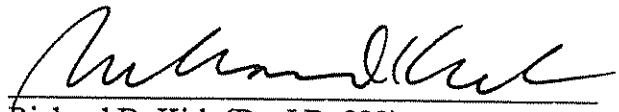
H. That this is an exceptional case and that LPL be awarded the attorneys' fees, costs and expenses that it incurs prosecuting this action; and

I. That LPL be awarded such other and further relief as this Court deems just and proper.

JURY DEMAND

Plaintiff demands a trial by jury of any and all issues triable of right by a jury.

THE BAYARD FIRM



Richard D. Kirk (Bar I.D. 922)
222 Delaware Avenue, Suite 900
P.O. Box 25130
Wilmington, DE 19899
(302) 429-4208
rkirk@bayardfirm.com
Attorneys for Plaintiff LG.Philips LCD Co., Ltd.

OF COUNSEL:

Gaspare J. Bono
Matthew T. Bailey
Andrew J. Park
Adrian Mollo
McKenna Long & Aldridge LLP
1900 K Street, NW
Washington, D.C. 20006
(202) 496-7500

May 13, 2005

EXHIBIT A

US006738121B2

(12) **United States Patent**
Yun et al.

(10) **Patent No.: US 6,738,121 B2**
(45) **Date of Patent: May 18, 2004**

(54) **TAPE CARRIER PACKAGE WITH DUMMY BENDING PART AND LIQUID CRYSTAL DISPLAY EMPLOYING THE SAME**

(75) Inventors: **Sai Chang Yun**, Kumi-shi (KR); **Eun Yeong An**, Kumi-shi (KR)

(73) Assignee: **LG. Philips LCD Co., Ltd.**, Seoul (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 277 days.

(21) Appl. No.: **09/814,828**

(22) Filed: **Mar. 23, 2001**

(65) **Prior Publication Data**

US 2001/0035930 A1 Nov. 1, 2001

(30) **Foreign Application Priority Data**

Mar. 31, 2000 (KR) P2000-17026

(51) **Int. Cl.**[7] **G02F 1/1345**
(52) **U.S. Cl.** **349/149**; 349/150; 349/151; 349/152
(58) **Field of Search** 349/149, 150

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,287,525	A *	9/1981	Tagawa	347/148
4,474,432	A *	10/1984	Takamatsu et al.	349/150
5,362,547	A *	11/1994	Yamazaki	428/167
5,398,128	A *	3/1995	Tajima et al.	349/150
5,528,403	A *	6/1996	Kawaguchi et al.	349/149
5,668,700	A *	9/1997	Tagusa et al.	361/779
5,670,994	A *	9/1997	Kawaguchi et al.	345/206
6,104,464	A *	8/2000	Adachi et al.	349/150

FOREIGN PATENT DOCUMENTS

JP	404304427 A	*	10/1992
JP	11271795		10/1999

* cited by examiner

Primary Examiner—John F. Niebling
Assistant Examiner—Angel Roman
(74) *Attorney, Agent, or Firm*—McKenna Long & Aldridge LLP

(57) **ABSTRACT**

A tape carrier package has dummy bending parts that are capable of reducing a brightness difference of a screen. In the tape carrier package, a pad part is connected to a liquid crystal panel. A base film is mounted with an integrated circuit chip for applying a signal to the liquid crystal panel. A dummy bending part is formed by removing the base film between the pad part and the integrated circuit chip to distribute a stress applied to the liquid crystal panel according to a thermal expansion of the pad part.

15 Claims, 7 Drawing Sheets

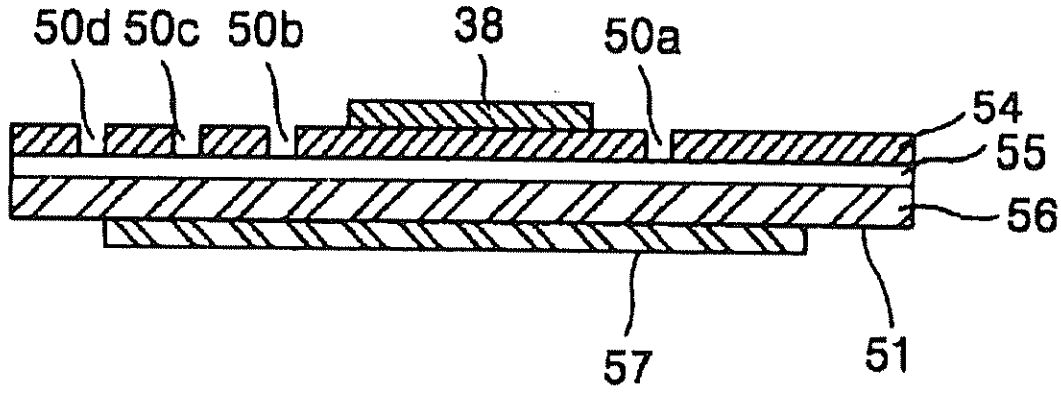


FIG. 1A

CONVENTIONAL ART

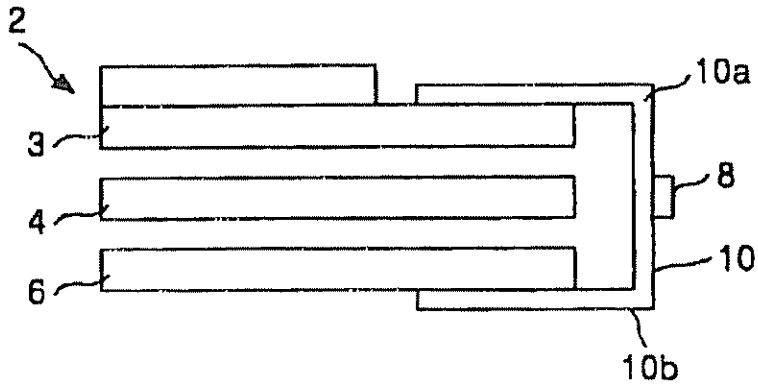


FIG. 1B

CONVENTIONAL ART

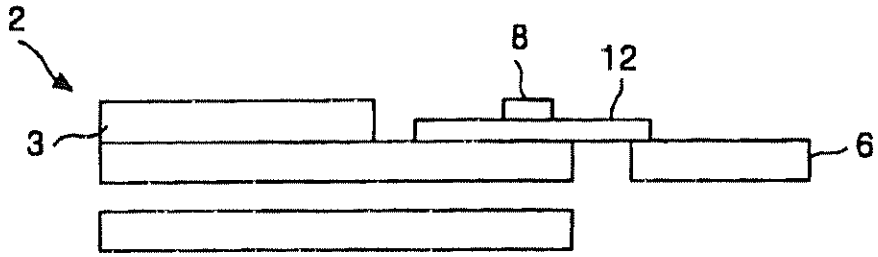


FIG. 2

CONVENTIONAL ART

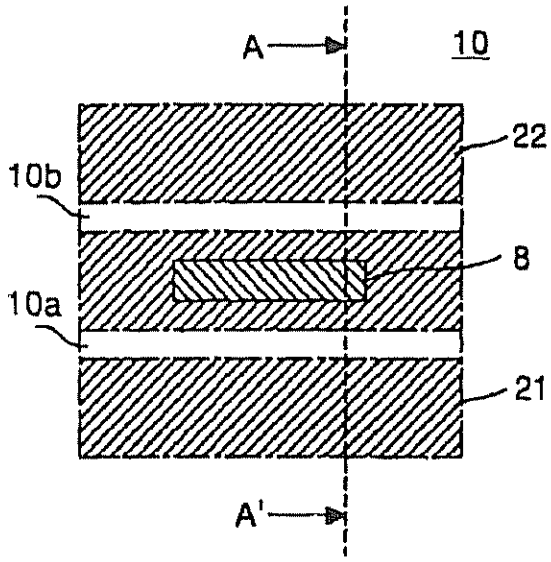


FIG. 3

CONVENTIONAL ART

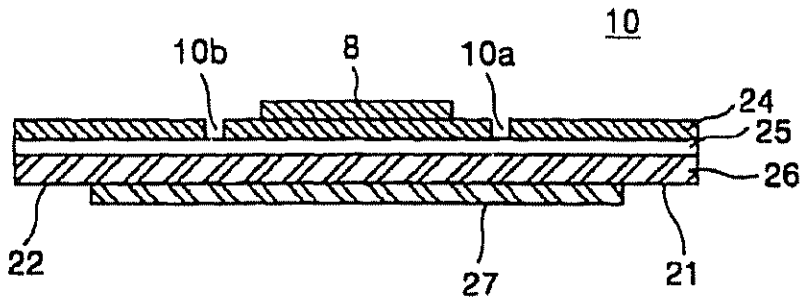


FIG. 4

CONVENTIONAL ART

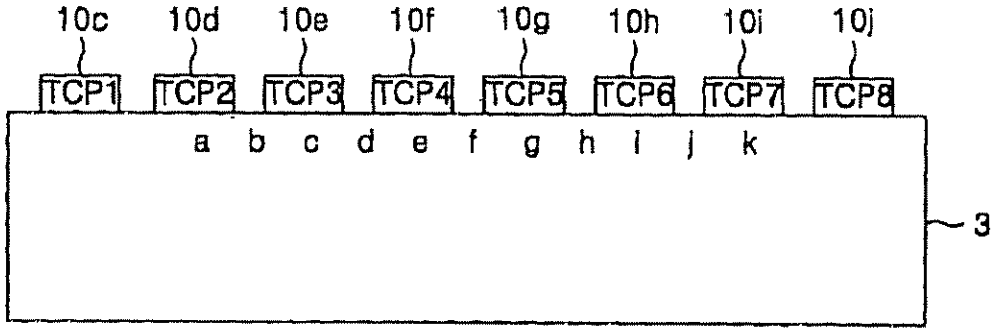


FIG. 5

CONVENTIONAL ART

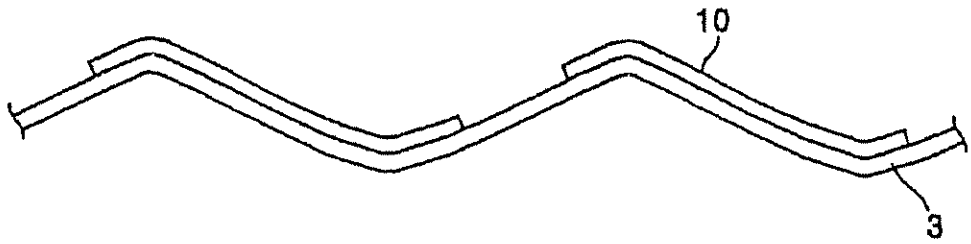


FIG. 6

CONVENTIONAL ART

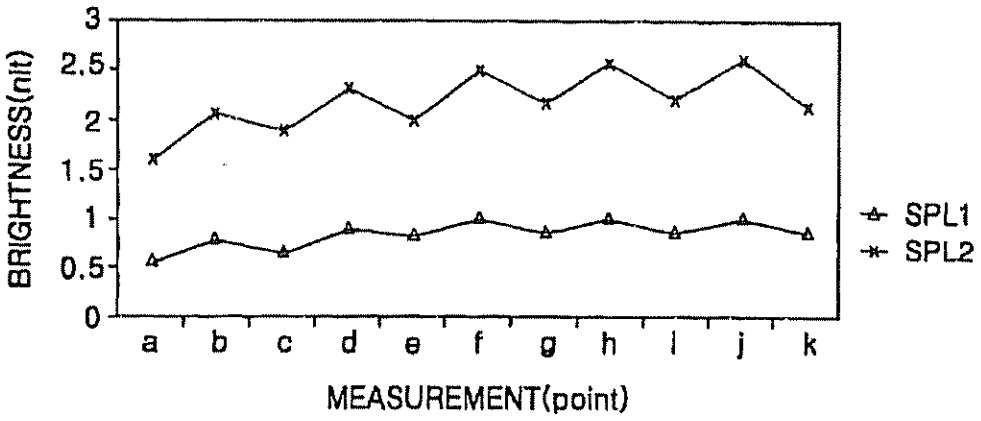


FIG. 7

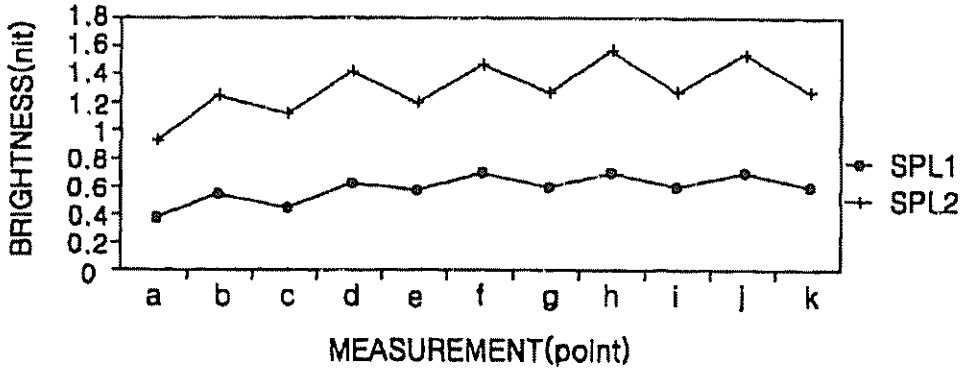


FIG. 8

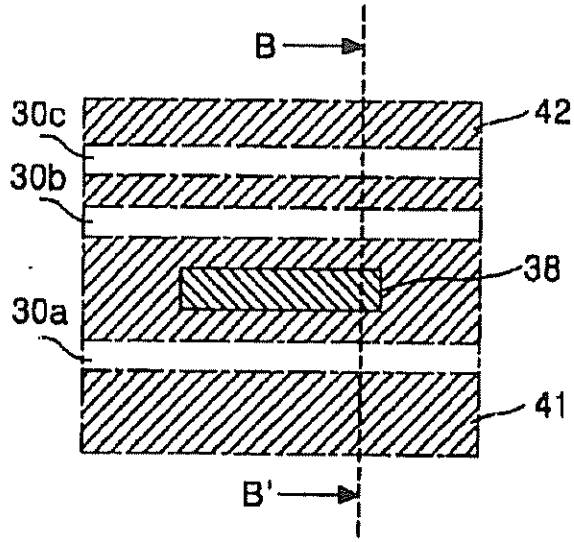


FIG. 9

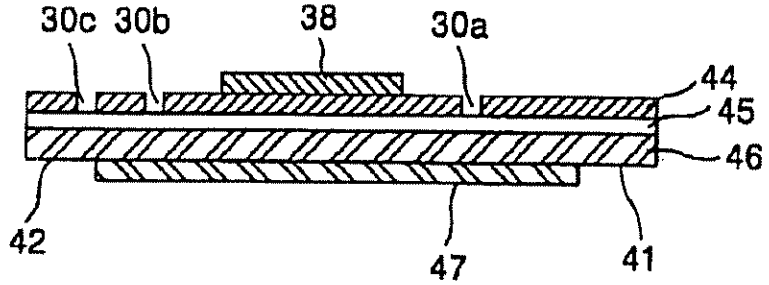


FIG. 10

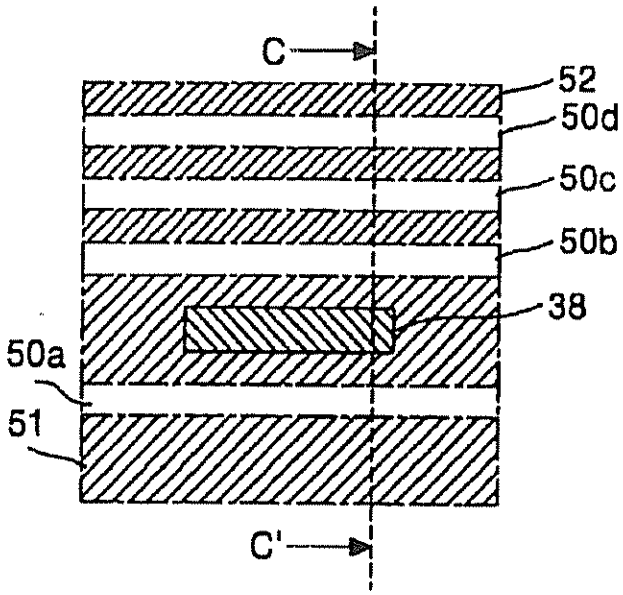


FIG. 11

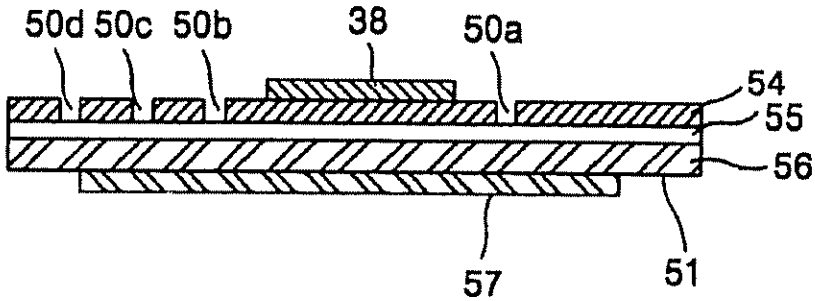


FIG. 12

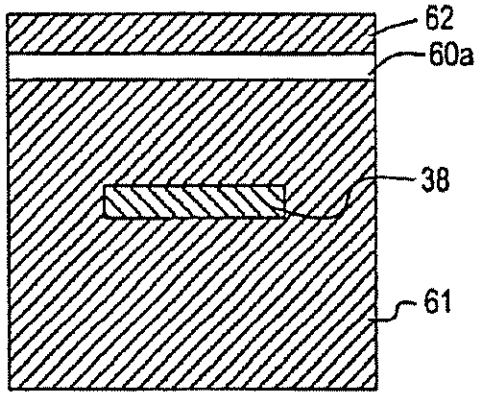
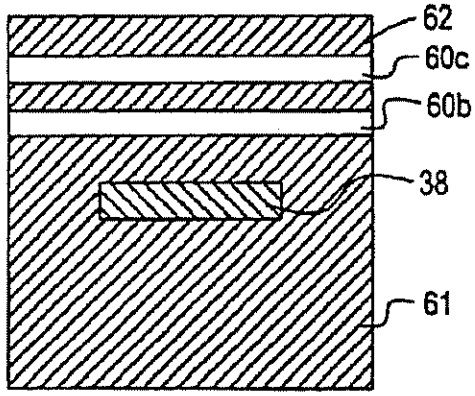


FIG. 13



TAPE CARRIER PACKAGE WITH DUMMY BENDING PART AND LIQUID CRYSTAL DISPLAY EMPLOYING THE SAME

This application claims the benefit of Korean Patent Application No. P2000-17026, filed on Mar. 31, 2000, which is hereby incorporated by reference for all purposes as if fully set forth herein.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to an apparatus for mounting an integrated circuit on a liquid crystal display, and more particularly to a tape carrier package with a dummy bending part that is capable of reducing a difference in brightness in a screen. Also, the present invention is directed to a liquid crystal display that is capable of reducing a difference in brightness, using said tape carrier package.

2. Description of the Related Art

Generally, a liquid crystal display with an active matrix driving system uses thin film transistors (TFTs) as switching devices to display a natural moving picture. Since such a liquid crystal display can be made into a smaller-size device than the Brown tube, it is commercially available for a monitor such as a portable television or a lap-top personal computer, etc.

The active matrix liquid crystal display displays a picture corresponding to video signals, such as television signals, on a pixel (or picture element) matrix having pixels arranged at each intersection between gate lines and data lines. Each pixel includes a liquid crystal cell for controlling a transmitted light quantity in accordance with a voltage level of a data signal from a data line. The TFT is installed at an intersection between the gate line and the data line to switch a data signal to be transferred to the liquid crystal cell in response to a scanning signal (i.e., a gate pulse) from the gate line.

Such a liquid crystal display requires a number of driving integrated circuits, each hereinafter referred to as a "D-IC", connected to the data lines and the gate lines to apply data signals and scanning signals to the data lines and the gate lines, respectively. The D-ICs are installed between the printed circuit board (PCB) and the liquid crystal panel to apply the data signals and the scanning signals to the data lines and the gate lines of the liquid crystal panel in response to a control signal applied from the PCB. A tape automated bonding (TAB) system has generally been used as a mounting method of the D-ICs that is capable of widening an effective area of the panel and has a relatively simple mounting process.

The TAB method may be divided into a bending type as shown in FIG. 1A, and a flat type as shown in FIG. 1B. The bending-type TAB system as shown in FIG. 1A has been used for a mounting of source and gate drivers of a monitor or a notebook computer. In the bending-type TAB system, a PCB **6** is folded to the rear side of a liquid crystal panel **2** by bending a tape carrier package (TCP) **10** mounted with a D-IC **8** and connected between a lower glass substrate **3** of the liquid crystal panel **2** and the PCB **6**. A backlight unit **4** is positioned below the liquid crystal display panel **2**. As shown in FIG. **2** and FIG. **3**, an adhesive **25** is coated on a base film **24** of the TCP **10**, and a lead part **26** is adhered thereon. The lead part **26** made from copper (Cu) is connected to pins of the D-IC **8**. On the lead **26** is coated a solder resistor **27** responsible for providing an insulator. At the upper end and the lower end of the base film **24**, an input pad part **21** and an output pad part **22** extending from each lead of the lead part **26** are provided. The input pad part **21** is connected to an output signal wiring of the PCB while the output pad part **22** is connected to the gate line or the data line formed on a lower glass substrate **3**. Bending parts **10***a* and **10***b* are provided between the input pad part **21** and the D-IC **8** and between the output pad part **22** and the D-IC **8**, respectively. The base film **24** is removed from the bending parts **10***a* and **10***b*. The TCP **10** is easily bent with the aid of these bending parts **10***a* and **10***b*.

The flat-type TAB system as shown in FIG. **1B** is mainly used to mount gate drivers of a 10.4" or 12.1" small-size notebook computer or monitor. In the flat-type TAB system, a TCP **12** mounted with a D-IC **8** and connected between a lower glass substrate **3** of a liquid crystal panel **2** and a PCB **6** is arranged in parallel to the liquid crystal panel **2**. Thus, since the TCP **12** connected between the liquid crystal panel **2** and the PCB **6** is not bent, no bending part is formed.

However, the conventional TAB system has a problem in that a brightness difference is generated between an area where the TCP **10** or **12** is adhered onto the liquid crystal panel **2** and an area where the TCP **10** or **12** is not adhered onto the liquid crystal panel **2**. More specifically, as shown in FIG. **4**, the TCPs **10***c* to **10***j* are adhered to the edge of the lower glass substrate **3** at a desired spacing, having an anisotropic conductive film (ACF) therebetween under a high temperature and high pressure atmosphere. At this time, the TCPs **10***c* to **10***j* are expanded by heat and then contracted while the heat applied thereto is lowered to a normal temperature after their adhesion. A stress is applied to the lower glass substrate **3** by such TCPs **10***c* to **10***j*. As a result, since the lower glass substrate **3** is deformed into a periodical land/groove shape as shown in FIG. **5**, a cell gap between an upper glass substrate (not shown) and the lower glass substrate **3** has a periodical thickness difference. When an experiment using the gray patterns of '7' and '3' was made with respect to two samples of a 12.1" liquid crystal panel as shown in FIG. **4** having SVGA resolution (i.e., 800×600) and a brightness of 300 nit, a brightness difference is periodically generated. As a result of this experiment, a brightness difference between the adhesive areas a, c, e, g, i and k and the non-adhesive areas b, d, f, h and i of the TCPs **10***c* to **10***j* having a difference in the cell gap is indicated in the following Table 1, and in FIGS. **6** and **7**. As a brightness measuring device, a 'PR800' model optical measuring-set is used for sensing a brightness level in accordance with a received light amount.

TABLE 1

Sample	Measuring Point	a	b	c	d	e	f	g	h	i	j	k
Sample 1	7-Gray	0.577	0.74	0.679	0.879	0.818	0.956	0.801	0.959	0.829	0.957	0.794
	3-Gray	0.44	0.538	0.491	0.642	0.577	0.703	0.584	0.707	0.604	0.712	0.596

TABLE 1-continued

Sample	Measuring Point	a	b	c	d	e	f	g	h	i	j	k
Sample 2	7-Gray	1.628	2.075	1.892	2.293	1.974	2.165	2.165	2.563	2.217	2.587	2.132
	3-Gray	1.925	1.233	1.089	1.369	1.129	1.464	1.258	1.564	1.291	1.549	1.245

As seen from Table 1, a brightness difference is generated between the adhesive areas a, c, e, g, i and k and the non-adhesive areas b, d, f, h and l of the TCPs **10***c* to **10***j*. In two samples, average brightness differences in the 7 gray pattern and the 3 gray pattern have 0.2691 and 0.1957, respectively. Since a stress applied to the lower glass substrate **3** by the TCPs **10***a* to **10***l* becomes larger as the TCPs **10***c* to **10***j* become longer or thicker, a brightness difference between the adhesive areas a, c, e, g, i and k and the non-adhesive areas b, d, f, h and l of the TCPs **10***c* to **10***j* becomes larger. Therefore, a strategy capable of reducing a brightness difference caused by the TCPs **10***c* to **10***j* is required to improve a display quality of the liquid crystal display.

FIG. **6** is a characteristic diagram of a brightness level detected from the liquid crystal panel shown in FIG. **4** with respect to a 7-gray pattern;

FIG. **7** is a characteristic diagram of a brightness level detected from the liquid crystal panel shown in FIG. **4** with respect to a 3-gray pattern;

SUMMARY OF THE INVENTION

Accordingly, it is an object of the present invention to provide a tape carrier package with a dummy bending part that is capable of reducing a brightness difference of the screen.

A further object of the present invention is to provide a liquid crystal display that is adaptive for reducing a brightness difference of the screen.

In order to achieve these and other objects of the invention, a tape carrier package according to one aspect of the present invention includes a pad part connected to a liquid crystal panel; a base film mounted with an integrated circuit chip for applying a signal to the liquid crystal panel; and a dummy bending part for distributing a stress applied to the liquid crystal panel according to a thermal expansion of the pad part by removing the base film between the pad part and the integrated circuit chip.

A tape carrier package according another aspect of the present invention includes a base film mounted with an integrated circuit chip for applying a signal to a liquid crystal panel; a pad part extending from the integrated circuit chip to be connected to the liquid crystal panel; at least one bending part in which the base film at a portion where the tape carrier package is folded is removed; and at least one dummy bending part, in which a desired base film at a portion where the tape carrier package is not folded is removed, for reducing a thermal expansion force and a thermal contraction force of the base film parallel to the longitudinal direction of the integrated circuit chip.

A liquid crystal display device according to still another aspect of the present invention includes a liquid crystal panel; a tape carrier package connected to the liquid crystal panel; a base film mounted with an integrated circuit chip for applying a signal to the liquid crystal panel; at least one bending part in which the base film at a portion where the tape carrier package is folded is removed; a dummy bending part, in which the base film is removed in a direction perpendicular to terminals of the pad part, for reducing a thermal expansion force and a thermal contraction force generated at the time of thermal-pressing the pad onto the liquid crystal panel; and a printed circuit board connected to an input pad part of the tape carrier package.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other objects of the invention will be apparent from the following detailed description of the embodiments of the present invention with reference to the accompanying drawings, in which:

FIG. **1A** is a sectional view showing the conventional bending-type tape automated bonding (TAB) system;

FIG. **1B** is a sectional view showing the conventional flat-type tape automated bonding (TAB) system;

FIG. **2** is a plan view showing the structure of the tape carrier package in FIG. **1A**;

FIG. **3** is a sectional view of the tape carrier package taken along a line A–A' in FIG. **2**;

FIG. **4** is a plan view showing the structure of a liquid crystal panel to which tape carrier packages used as a sample for brightness measurement are attached;

FIG. **5** depicts a deformation of the lower substrate glass substrate caused by the tape carrier package;

FIG. **6** is a characteristic diagram of a brightness level detected from the liquid crystal panel shown in FIG. **4** with respect to a 7-gray pattern;

FIG. **7** is a characteristic diagram of a brightness level detected from the liquid crystal panel shown in FIG. **4** with respect to a 3-gray pattern;

FIG. **8** is a plan view showing the structure of a tape carrier package according to a first embodiment of the present invention;

FIG. **9** is a sectional view of the tape carrier package taken along line B–B' in FIG. **8**;

FIG. **10** is a plan view showing the structure of a tape carrier package according to a second embodiment of the present invention;

FIG. **11** is a sectional view of the tape carrier package taken along line C–C' in FIG. **10**;

FIG. **12** is a plan view showing the structure of a tape carrier package according to a third embodiment of the present invention; and

FIG. **13** is a plan view showing the structure of a tape carrier package according to a fourth embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. **8** and FIG. **9**, there is shown a tape carrier package (TCP) according to a first embodiment of the present invention, which is applicable to the bending-type

TAB system. The TCP includes a D-IC **38** mounted on a base film **44**, a first bending part **30***a* provided between an input pad part **41** and the D-IC **38**, and a second bending part **30***b* and a dummy bending part **30***c* provided between an output pad part **42** and the D-IC **38** in parallel. The D-IC **38** plays a role to apply scanning signals, or data, to gate lines or data lines of a liquid crystal panel **2**. Output pins of the D-IC **38** are connected to a lead part **46** adhered onto the base film **44** by means of an adhesive **45**.

The lead part **46** is coated with a solder resistor **47** responsible for providing an insulator. At the input pad part **41** are formed pads extending from the lead part **46** to be connected to an output signal wiring of a PCB **6**. Between the input pad part **41** and the D-IC **38** is provided the first bending part **30***a* in which the base film **44** is removed. The TCP between the PCB **6** and the D-IC **38** is easily bent by the first bending part **30***a*. At the output pad part **42** are provided pads extending from the lead part **46** to be connected to pads formed at the edge of the lower glass substrate **3**. Between the output pad part **42** and the D-IC **38** is provided the second bending part **30***b* and the dummy bending part **30***c* in which the base film **44** are removed. The TCP between the liquid crystal panel **2** and the D-IC **38** is easily bent by the second bending part **30***b*. The dummy bending part **30***c* reduces the TCP area to which heat is applied at the time of adhering the TCP to the lower glass substrate. Accordingly, since the amount of thermal expansion of the TCP is reduced, the stress applied to the lower glass substrate **3** by the TCP is distributed and thus reduced.

Referring to FIG. **10** and FIG. **11**, there is shown a tape carrier package (TCP) according to a second embodiment of the present invention, which is applicable to the bending-type TAB system. The TCP includes a D-IC **38** mounted on a base film **54**, a first bending part **50***a* provided between an input pad part **51** and the D-IC **38**, and a second bending part **50***b*, a first dummy bending part **50***c* and a second dummy bending part **50***d* provided between an output pad part **52** and the D-IC **38** in parallel to each other. At the input pad part **51** are formed pads extending from the lead part **56** to be connected to an output signal wiring of a PCB **6**. Between the input pad part **51** and the D-IC **38** is provided the first bending part **50***a* in which the base film **54** is removed. The TCP between the PCB **6** and the D-IC **38** is easily bent with the aid of the first bending part **50***a*. At the output pad part **52** are provided pads extending from the lead part **56** to be connected to pads formed at the edge of the lower glass substrate **3**. Between the output pad part **52** and the D-IC **38** are provided the second bending part **50***b*, the first dummy bending part **50***c* and the second dummy bending part **50***d* in which each of the base film **54** is removed. The TCP between the liquid crystal panel **2** and the D-IC **38** is easily bent by the second bending part **50***b*. The first and second dummy bending parts **50***c* and **50***d* play a role to distribute and reduce a stress applied to the lower glass substrate **3** by the TCP. A TCP area to which heat is applied at the time of adhering the TCP onto the lower glass substrate **3** is reduced more than in the TCP of FIG. **8**, with the aid of the second dummy bending part **50***d*.

Referring to FIG. **12** and FIG. **13**, there are shown tape carrier packages (TCPs) according to other embodiments of the present invention, which are applicable to the flat-type TAB system. Each of the TCPs includes a D-IC **38** mounted on a base film **54**, and at least one of dummy bending part **60***a* or **60***b* and **60***c* between an output pad part **62** and the D-IC **38**. At the input pad part **61** are formed pads extending from the lead part **56** to be connected to an output signal wiring of a PCB **6**. At the output pad part **62** are provided pads extending from the lead part **56** to be connected to pads formed at the edge of the lower glass substrate **3**. Between the output pad part **62** and the D-IC **38** are provided one or two dummy bending parts **60***a* or **60***b* and **60***c* in which the base film **54** is removed. The dummy bending parts **60***a*, **60***b* and **60***c* play a role to distribute and reduce a stress applied to the lower glass substrate **3** by the TCP.

As described above, according to the present invention, the base film close to the output pads adhered onto the glass substrate of the liquid crystal panel is removed, so that a stress applied to the glass substrate by the TCP is distributed and thus reduced. As a result, the TCP with dummy bending parts according to the present invention can reduce a brightness difference of the screen. Furthermore, according to the present invention, the TCP having the dummy bending parts is adhered, so that a stress applied to the glass substrate as well as a cell gap difference between the adhesive area and the non-adhesive area of the TCP is reduced to that extent. Accordingly, the liquid crystal display according to the present invention maintains the cell gap constantly at the adhesive area and the non-adhesive area of the TCP, so that it is capable of reducing a brightness difference of the screen.

Although the present invention has been explained by the embodiments shown in the drawings described above, it should be understood to the ordinary skilled person in the art that the invention is not limited to the embodiments, but rather that various changes or modifications thereof are possible without departing from the spirit of the invention. Accordingly, the scope of the invention shall be determined only by the appended claims and their equivalents

What is claimed is:

1. A liquid crystal display device, comprising:

a liquid crystal panel;

a printed circuit board; and

a tape carrier package connected to the liquid crystal panel and the printed circuit board, the tape carrier package comprising:

a base film mounted with an integrated circuit chip for applying a signal to the liquid crystal panel;

an output pad part extending from the integrated circuit chip and having terminals connected to the liquid crystal panel;

a dummy bending part in which a portion of the base film is removed in a direction perpendicular to the terminals of the output pad part for reducing a thermal expansion force and a thermal contraction force generated when thermal-pressing the output pad part onto the liquid crystal panel;

a first bending part in which a second portion of the base film existing at a bent position between the dummy bending part and the integrated circuit chip is removed; and

an input pad part extending from the integrated circuit chip and having terminals connected to the printed circuit board,

wherein the dummy bending part is formed at a position, close to any one of the output pad part or the input pad part, where the tape carrier package is not folded.

2. A liquid crystal display device, comprising:

a liquid crystal panel;

a printed circuit board; and

a tape carrier package connected to the liquid crystal panel and the printed circuit board, the tape carrier package comprising:

a base film mounted with an integrated circuit chip for applying a signal to the liquid crystal panel;

an output pad part extending from the integrated circuit chip and having terminals connected to the liquid crystal panel;

a dummy bending part in which a portion of the base film is removed in a direction perpendicular to the terminals of the output pad part for reducing a thermal expansion force and a thermal contraction force generated when thermal-pressing the output pad part onto the liquid crystal panel;

a first bending part in which a second portion of the base film existing at a bent position between the dummy bending part and the integrated circuit chip is removed;

an input pad part extending from the integrated circuit chip and having terminals connected to the printed circuit board; and

a second bending part in which a third portion of the base film existing at a bent position between the input pad part and the integrated circuit chip is removed.

3. The liquid crystal display panel of claim 2, wherein the tape carrier package further comprises a second dummy bending part in which a fourth portion of the base film is removed in a direction perpendicular to the terminals of the output pad part.

4. The liquid crystal display device of claim 1, wherein the tape carrier package further comprises a second dummy bending part in which a third portion of the base film is removed in a direction perpendicular to the terminals of the output pad part.

5. A tape carrier package, comprising:

a pad part for connection to a liquid crystal panel;

a base film mounted with an integrated circuit chip for applying a signal to the liquid crystal panel; and

a dummy bending part for distributing a stress applied to the liquid crystal panel according to a thermal expansion of the pad part by removing a portion of the base film between the pad part and the integrated circuit chip,

wherein the dummy bending part is formed at a position, close to the pad part, where the tape carrier package is not folded.

6. The tape carrier package according to claim 5, further comprising a first bending part in which a second portion of the base film is removed at a bent position between the dummy bending part and the integrated circuit chip.

7. The tape carrier package according to claim 6, further comprising a second pad part for connection to a printed circuit board.

8. A tape carrier package, comprising:

a pad part for connection to a liquid crystal panel;

a base film mounted with an integrated circuit chip for applying a signal to the liquid crystal panel;

a dummy bending part for distributing a stress applied to the liquid crystal panel according to a thermal expansion of the pad part by removing a portion of the base film between the pad part and the integrated circuit chip;

a first bending part in which a second portion of the base film is removed at a bent position between the dummy bending part and the integrated circuit chip;

a second pad part for connection to a printed circuit board; and

a second bending part in which a third portion of the base film is removed at a bent position between the second pad and the integrated circuit chip.

9. The tape carrier package according to claim 5, further comprising a second pad part for connection to a printed circuit board.

10. The tape carrier package according to claim 5, further comprising a second dummy bending part in which a second portion of the base film is removed.

11. The tape carrier package according to claim 10, further comprising a first bending part in which a third portion of the base film is removed at a bent position between the dummy bending part and the integrated circuit chip.

12. The tape carrier package according to claim 11, further comprising a second pad part for connection to a printed circuit board.

13. A tape carrier package, comprising:

a pad part for connection to a liquid crystal panel;

a base film mounted with an integrated circuit chit for applying a signal to the liquid crystal panel;

a dummy bending part for distributing a stress applied to the liquid crystal panel according to a thermal expansion of the pad part by removing a portion of the base film between the pad part and the integrated circuit chip;

a second dummy bending part in which a second portion of the base film is removed;

a first bending part in which a third portion of the base film is removed at a bent position between the dummy bending part and the integrated circuit chip;

a second pad part for connection to a printed circuit board; and

a second bending part in which a fourth portion of the base film is removed at a bent position between the second pad and the integrated circuit chip.

14. A tape carrier package, comprising:

a base film mounted with an integrated circuit chip for applying a signal to a liquid crystal panel;

a pad part extending from the integrated circuit chip to be connected to the liquid crystal panel;

at least one bending part in which a portion of the base film is removed at an area where the tape carrier package is folded; and

at least one dummy bending part, in which a second portion of the base film is removed at a portion where the tape carrier package is not folded, thereby reducing a thermal expansion force and a thermal contraction force of the base film parallel to a longitudinal direction of the integrated circuit chip.

15. The tape carrier package according to claim 14, wherein said dummy bending part is positioned on the pad part.

* * * * *

EXHIBIT B

United States Patent [19]

Holmberg

[11] **Patent Number: 5,019,002**

[45] **Date of Patent: May 28, 1991**

[54] **METHOD OF MANUFACTURING FLAT PANEL BACKPLANES INCLUDING ELECTROSTATIC DISCHARGE PREVENTION AND DISPLAYS MADE THEREBY**

[75] Inventor: **Scott H. Holmberg, San Ramon, Calif.**

[73] Assignee: **Honeywell, Inc., Minneapolis, Minn.**

[21] Appl. No.: **218,312**

[22] Filed: **Jul. 12, 1988**

[51] Int. Cl.[5] **H01L 45/00**

[52] U.S. Cl. **445/24**; 357/23.13; 437/56

[58] Field of Search 445/24, 3; 357/23.13, 357/4; 437/4, 8, 56

[56] **References Cited**

U.S. PATENT DOCUMENTS

4,455,739	6/1984	Hynecek	427/8 X
4,586,242	5/1986	Harrison	437/8
4,714,949	12/1987	Simmons et al.	357/23.13
4,736,271	4/1988	Mack et al.	357/23.13
4,803,536	2/1989	Tuan	357/23.13

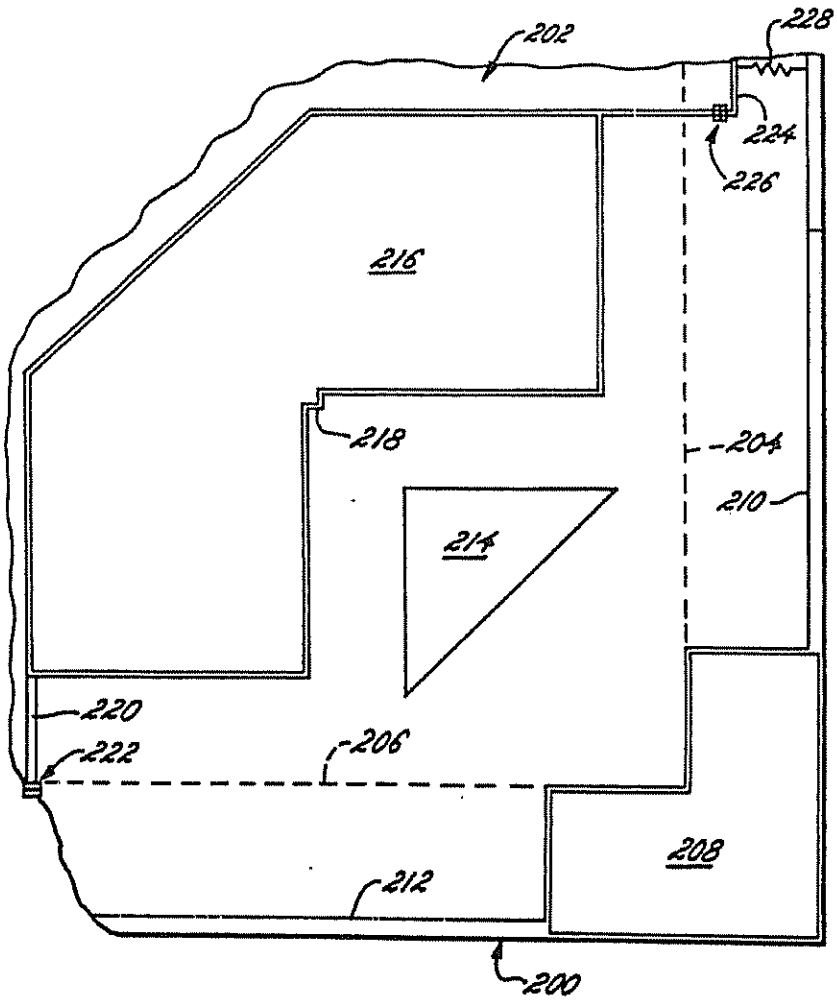
Primary Examiner—Kenneth J. Ramsey

Attorney, Agent, or Firm—Leydig, Voit & Mayer

[57] **ABSTRACT**

Flat panel displays are provided including protection from electrostatic discharge (ESD) during manufacture and thereafter. At least one ESD guard ring is provided to protect the active elements of the display from the potential discharge between the row and column lines. An internal ESD guard ring is coupled to the row and column lines via shunt transistors. An external ESD guard ring is coupled to the row and column lines via a resistance. Both of the guard rings can be provided; however, the external guard ring is removed prior to completion of the display.

36 Claims, 5 Drawing Sheets



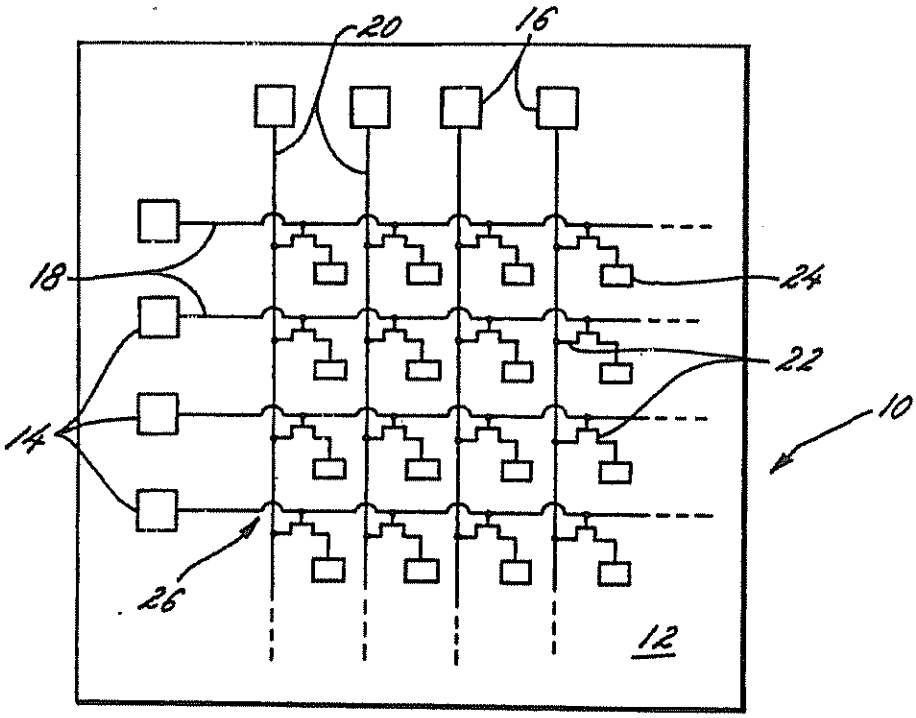


FIG. 1

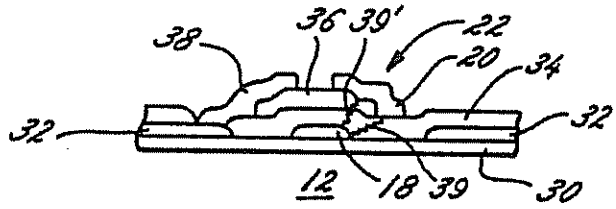
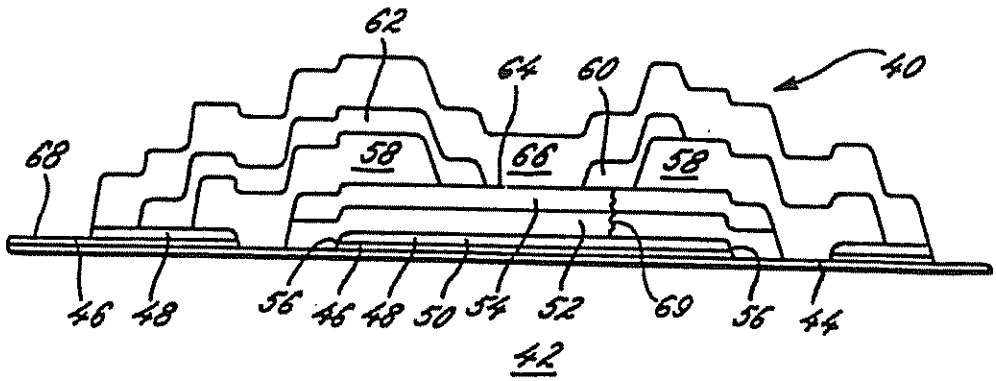


FIG. 2

FIG. 3



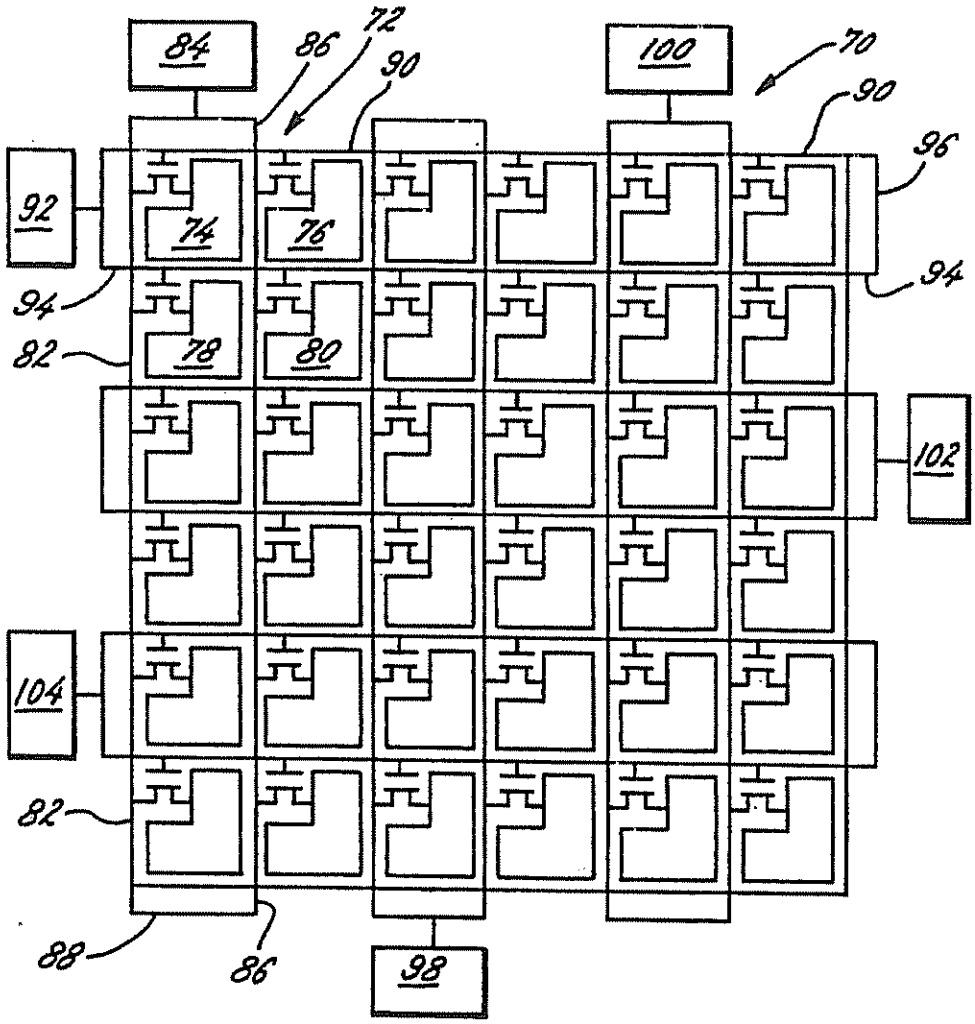
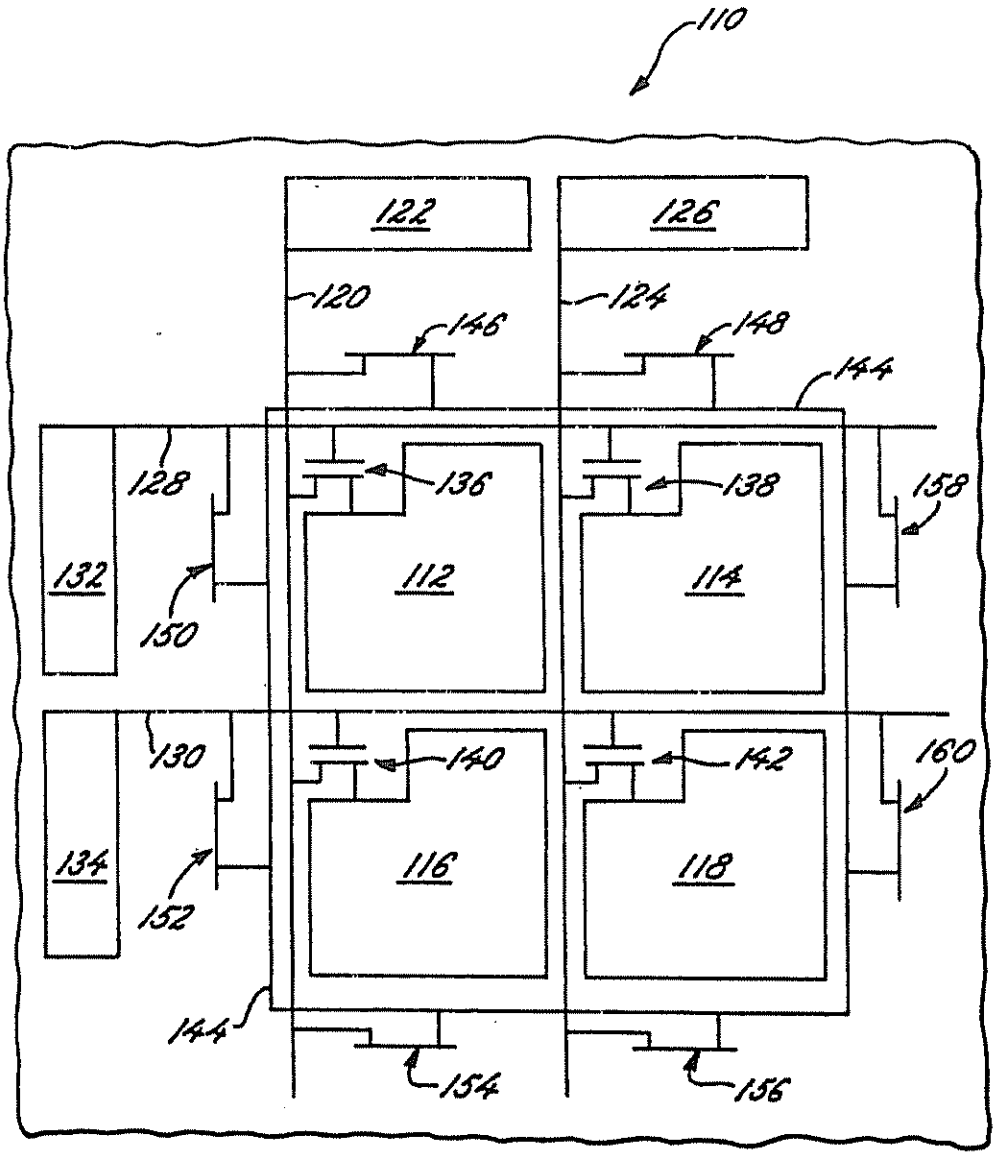


FIG. 4

FIG. 5


110
122
126
120
124
146
148
144
128
136
138
158
132
112
114
150
130
140
142
160
134
116
118
152
144
154
156

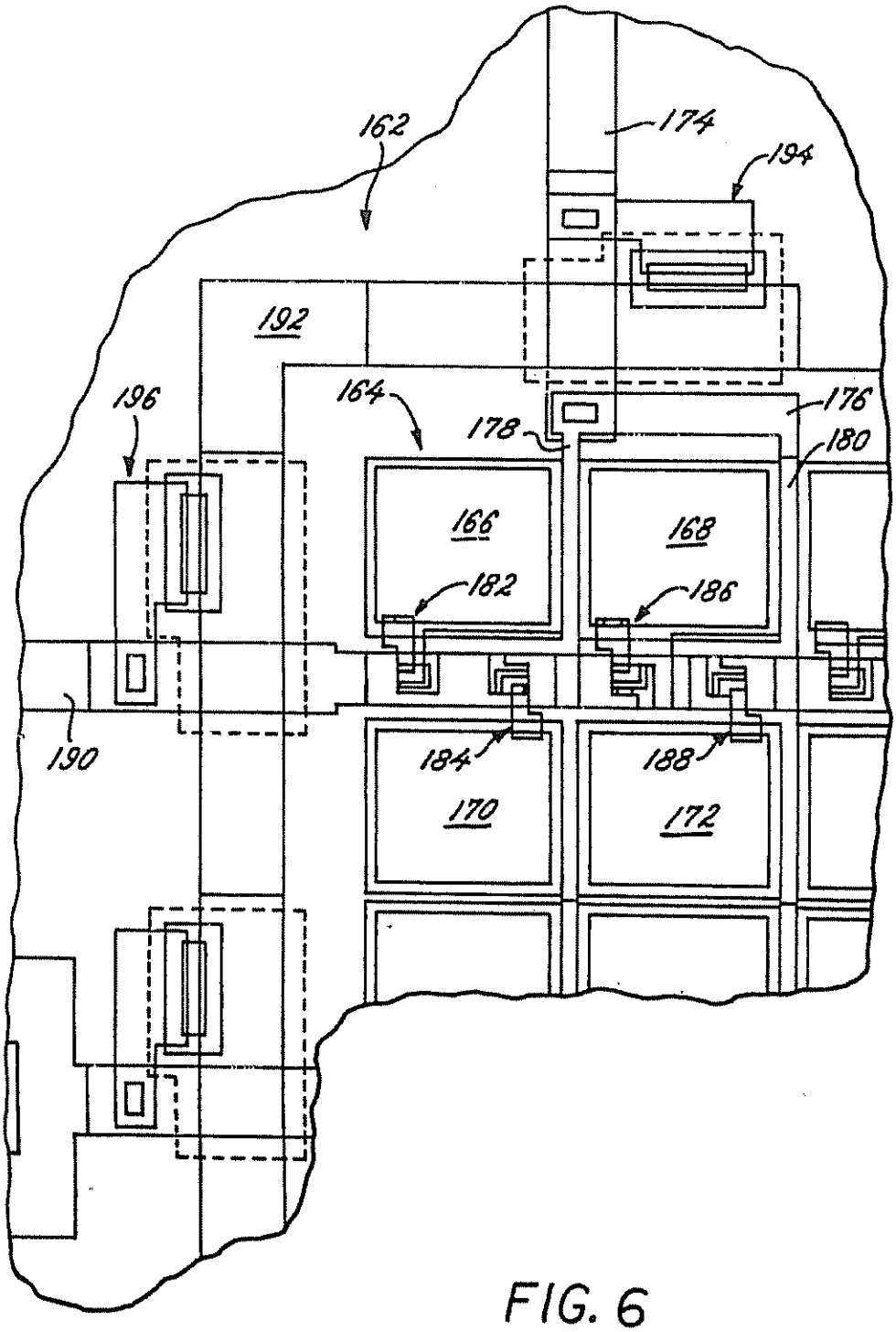

162
174
194
192
196
164
178
176
180
166
168
182
186
190
184
188
170
172

FIG. 6

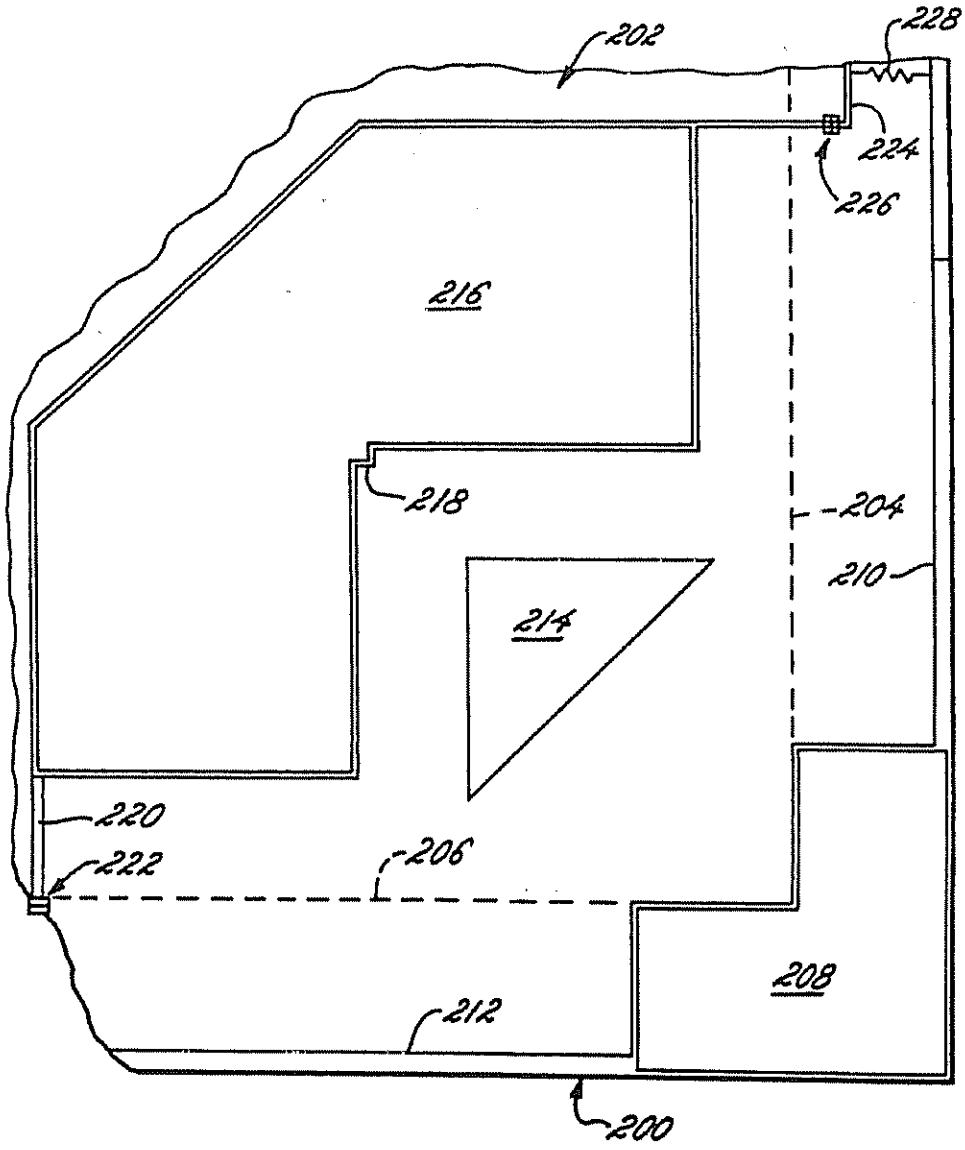


FIG. 7

METHOD OF MANUFACTURING FLAT PANEL BACKPLANES INCLUDING ELECTROSTATIC DISCHARGE PREVENTION AND DISPLAYS MADE THEREBY

BACKGROUND OF THE INVENTION

The present invention pertains to improved flat panel displays and methods of making the displays with protection from electrostatic discharges. More particularly, the present invention is directed to methods of increasing the manufacturing yields of flat panel display backplanes and the displays made therefrom by improving handling characteristics.

In recent years there has been growing interest in flat panel displays, such as those which employ liquid crystals, electrochromic or electroluminescence, as replacements for conventional cathode ray tubes (CRT). The flat panel displays promise lighter weight, less bulk and substantially lower power consumption than CRT's. Also, as a consequence of their mode of operation, CRT's nearly always suffer from some distortion. The CRT functions by projecting an electron beam onto a phosphor-coated screen. The beam will cause the spot on which it is focused to glow with an intensity proportional to the intensity of the beam. The display is created by the constantly moving beam causing different spots on the screen to glow with different intensities. Because the electron beam travels a further distance from its stationary source to the edge of the screen than it does to the middle, the beam strikes various points on the screen at different angles with resulting variation in spot size and shape (i.e. distortion).

Flat panel displays are manufactured to be substantially free of such distortion. In the manufacture of flat panel displays the circuit elements are deposited and patterned, generally by photolithography, on a substrate, such as glass. The elements are deposited and etched in stages to build a device having a matrix of perpendicular rows and columns of circuit control lines with a pixel contact and control element between the control line rows and columns. The pixel contact has a medium thereon which is a substance that either glows (active) or changes its response to ambient light (passive) when a threshold voltage is applied across the medium control element. The medium can be a liquid crystal, electroluminescent or electrochromic materials such as zinc sulfide, a gas plasma of, for example, neon and argon, a dichroic dye, or such other appropriate material or device as will luminesce or otherwise change optical properties in response to the application of voltage thereto. Light is generated or other optical changes occur in the medium in response to the proper voltage applied thereto. Each optically active medium is generally referred to as a picture element or "pixel".

The circuitry for a flat panel display is generally designed such that the flat panel timeshares, or multiplexes, digital circuits to feed signals to one row and column control line of the pixels at a time. Generally one driving circuit is used for each row or column control line. In this way a subthreshold voltage can be fed to an entire row containing hundreds of thousands of pixels, keeping them all dark or inactive. Then a small additional voltage can be supplied selectively to particular columns to cause selected pixels to light up or change optical properties. The pixels can be made to glow brighter by applying a larger voltage or current of a longer pulse of voltage or current. Utilizing liquid crystal displays (LCD's) with twisted nematic active material, the display is substantially transparent when not activated and becomes light absorbing when activated. Thus, the image is created on the display by sequentially activating the pixels, row by row, across the display. The geometric distortion described above with respect to CRT's is not a factor in flat panel displays since each pixel sees essentially the same voltage or current.

One of the major problems that arises with respect to the prior art method of manufacture of backplanes for active matrix displays (e.g. those employing thin film transistors at each pixel) is that they generally suffer production yield problems similar to those of integrated circuits. That is, the yields of backplanes produced are generally not 100% and the yield (percentage of backplanes with no defects) can be 0% in a worst case. High quality displays will not tolerate any defective pixel transistors or other components. Also, larger size displays are generally more desirable than smaller size displays. Thus, a manufacturer is faced with the dilemma of preferring to manufacture larger displays, but having to discard the entire product if even one pixel is defective. In other words, the manufacturer suffers a radically increased manufacturing cost per unit resulting from decreasing usable product yield.

One solution to the low yield problem is disclosed in U.S. Ser. No. 948,224, filed Dec. 31, 1986, now U.S. Pat. No. 4,676,761 entitled "Method of Manufacturing Flat Panel Backplanes Including Improved Testing and Yields Thereof and Displays Made Thereby", which is owned by the assignee of the present application and is incorporated herein by reference.

These problems of increased cost and decreased yield are improved in the present invention by providing methods of manufacturing display backplanes and the resulting displays with electrostatic discharge protection which provide protection against fatal defects during and after manufacture of the displays.

SUMMARY OF THE INVENTION

There is provided improved methods of manufacturing backplanes and the resulting flat panel displays to increase the manufacturing yield, decrease manufacturing costs and substantially eliminate fatal display defects caused by electrostatic discharge during manufacture and thereafter.

These improvements are accomplished by forming at least one electrostatic discharge (ESD) guard ring around the active elements of the display. An internal ESD guard ring can be formed, which provides a discharge path for static potential applied across the row and column line of the display. This prevents the potential from discharging between the row and column lines through an active element causing a short and resulting in a defect in the display during manufacture or thereafter. An external ESD guard ring can be formed, which provides protection during manufacture of the displays, however, the external ESD guard ring is removed at the end of the display manufacturing process. The displays also can include both the internal and external ESD guard ring to provide protection during manufacture and thereafter.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a plan view schematic representation of an active matrix display backplane made by a prior art method;

FIG. 2 is a cross-section of one transistor of the prior art backplane which could be utilized with the present invention;

FIG. 3 is a cross-section of one transistor which could be utilized with the present invention;

FIG. 4 is a plan view schematic representation of one prior embodiment of a subpixel matrix display;

FIG. 5 is a plan view schematic representation of a matrix display illustrating one embodiment of an internal ESD guard ring of the present invention;

FIG. 6 is an enlarged plan view of a portion of one embodiment of a subpixel matrix display illustrating the internal ESD guard ring in accordance with the present invention; and

FIG. 7 is a partial plan view of one embodiment of an exterior ESD guard ring of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now more particularly to FIG. 1, there is shown a schematic representation of an active matrix flat panel display device 10 made in accordance with conventional photolithographic techniques. One such device 10 and the manufacture thereof is more fully described in Application of Amorphous Silicon Field Effect Transistors in Addressable Liquid Crystal Display Panels, A. J. Snell, et al., *Applied Physics*, No. 24, p. 357, 1981. The device 10 includes a substrate 12, sets of contact pads 14 and 16, sets of control or bus lines 18 and 20, and, in this particular example of the prior art, transistors 22 and pixel back contacts 24.

The substrate 12 commonly employed in these devices is formed from glass. The control lines 18 and 20 are organized into a matrix of rows 18 and columns 20. The control line rows 18 in this device 10 serve as gate electrodes and the control line columns 20 as source connections. One contact pad 14 is connected to one end of each of the row control lines 18. One contact pad 16 is connected to one end of each of the column control lines 20. The display drive control (not shown) is connected to the sets of pads 14 and 16.

At each matrix crossover point 26, where a row line 18 and a column line 20 cross, a switching element, transistor 22 is formed to connect the row line 18 and column line 20 to the pixel back contacts 24. The active medium is deposited at least on the contacts 24 which will optically change properties in response to the combined voltages or currents in the respective crossover point 26 formed by the row 18 and column 20. The active medium at a given crossover point 26 will appear as a square or dot in the overall checkerboard type matrix of the display 10. The actual size of the transistors 22 and the contacts 24 are not now drawn to scale, but are shown schematically for illustration only.

It should be noted that theoretically there is no limit on the number of rows 18 and columns 20 that can be employed, only a portion of which are illustrated in FIG. 1. Therefore, there is also no theoretical limit on the outside dimensions of such a device 10. However, the present state of the lithographic art places a practical limit on the outside dimensions of these devices. The present alignment techniques generally allow high resolution display devices to be manufactured approximately five inches on a side 28, although improved techniques of up to fourteen inches on a side has been demonstrated.

The problem encountered by the prior art method of manufacture is that if the array of device 10 contains any defective pixel transistors 22 or other circuit elements causing a pixel to be inoperative, it must be discarded.

Referring in detail to FIG. 2, several problems occur when the switching element, transistor 22 is manufactured. The substrate 12 is a substantial portion of the backplane cost and hence an inexpensive soda-lime glass is generally utilized. It has been demonstrated by liquid crystal display manufacturers that the high sodium concentration can poison the liquid crystal materially diffusing through the overlying ITO layer and hence an SiO_2 suppression layer 30 is generally formed on the substrate 12. There are some high quality low sodium types of substrates available, which would not need the suppression layer 30. An ITO layer 32 is formed and etched to provide an ITO free area on which the gate 18 is deposited. Following the deposition of the gate 18, a gate insulator layer 34 is deposited. Although a smooth uniform coverage of the gate 18 by the insulator 34 is illustrated, in production the gate 18 has or can have sharp edges which lead to pin holes or thinning of the insulator 34 at the gate edges. The source and drain metals can short to the gate 18. The thinning or pin holes produce transistors 22, which if operative, do not have uniform operating characteristics and hence the backplane is worthless.

One attempt to solve this problem, is to make the gate 18 very thin, but the resistivity is then too high to make the large arrays necessary for the backplane. A second attempt to solve the problem, is to make the gate insulator 34 very thick, but this decreases the gain of the transistor 22 and is also self defeating.

An amorphous silicon layer 36 is then deposited, with the source 20 and a drain 38 deposited thereover. A passivating layer (not shown) would be deposited over the completed structure to complete the transistor 22. During operation the activation of the source 20 and the gate 18 couples power through the silicon alloy 36 to the drain and hence to the contact pad 24 formed by the ITO layer 32.

During manufacture of the device 10, electrostatic discharge can occur when a high static electric potential is coupled across at least one pair of the gate lines 18 and the source lines 20. The discharge frequently will result in a short 39 through the insulator 34 or a short 39' through the insulator 34 and the silicon layer 36 in the transistor 22, between the adjacent crossover points of the lines 18 and 20 as can be seen in FIG. 2. This will cause at least one row and one intersecting column of the display pixels to be defective and in the type of display device 10, generally the defect will be a fatal one (clearly visible) and hence the device will be discarded. The device 10 does not provide any redundancy or subpixels and hence the defect cannot easily be isolated.

Referring now to FIG. 3, there is shown a schematic representation of one embodiment of a transistor 40 which can be utilized with the present invention. The transistor is more fully disclosed in U.S. Pat. Nos. 4,545,112 and 4,736,229, which are incorporated herein by reference.

A glass substrate 42 includes a barrier SiO_2 layer 44 thereon. As above mentioned, a low sodium glass sub-

strate, such as Corning 7059 glass, could be utilized, and hence the barrier layer 44 can be eliminated. The detailed deposition steps are described in the above-referenced patent and application. An ITO layer 46 is deposited and then a refractory metal layer 48 is deposited on the ITO layer 46.

The layers 46 and 48 are etched to form a gate electrode 50. A gate insulator 52 and a semiconductor material 54 are sequentially deposited over the gate 50. The material 54 preferably is an amorphous silicon alloy. To avoid the possibility of any gate to source or drain shorts at gate edges 56, a dielectric 58 is deposited over the gate 55, the gate insulator 52 and the semiconductor 54. The dielectric 58 is deposited to a sufficient thickness to ensure that no shorts or thin spots are formed between the edges 56 of the gate 50 and a source 60 and a drain 62 deposited thereover.

The dielectric 58 is etched away only on a substantially planar central region 64 of the semiconductor layer 54. This insures uniform operating characteristics for the transistors 40 in the backplane array. A passivating layer 66 is deposited over the whole structure to complete the structure of the transistor 40.

During all of the transistor processing steps, the refractory metal layer 48 remains over a pixel contact pad 68 upon which the active material of the pixel is deposited. As a final step, before the active medium (not shown) is added to the backplane to complete the display, the refractory metal is etched off of the pixel pad 68 leaving the ITO layer 46 exposed after all the processing has been completed.

The gate to source or drain shorts referred to above in discussing the dielectric 58, refer to physical shorts caused by thin spots or actual metal particles or filaments. The electrostatic discharges caused during manufacturing and thereafter will be deterred by the dielectric 58, but will not be eliminated. The potential can be high enough to again form a short 69 through the gate insulator 52 and the semiconductor material 54 in the transistor 40, between the source 60 and the gate 50. Depending upon the display structure, at least one pixel or one subpixel (FIG. 4) will be defective.

Referring now to FIG. 4, a subpixel matrix display of the above-referenced application, U.S. Ser. No. 948,224, is designated generally by the reference numeral 70. The subpixel matrix display 70 is illustrated as having each pixel subdivided into four subpixels, but the pixels could be subdivided into numerous other configurations such as two subpixels, two by four or six subpixels or in three subpixels for color applications. Each pixel 72 is subdivided into four subpixels 74, 76, 78 and 30 (only one pixel 72 is so numbered for illustration). As previously stated, the number of pixels is merely shown for illustration purposes and the display 70 could contain any desired number and configuration, square or rectangular.

A column (source) line or bus 82 connects the subpixels 74 and 78 and all other column subpixel pairs in one-half of each of the pixels to a column or source contact pad 84 at one edge of the display 70. A second column (source) line or bus 86 connects the subpixels 76 and 80 and all other column subpixel pairs in the second half of each of the pixels to the column or source contact pad 84. The bus lines 82 and 86 are interconnected (shorted) at or before the pad 84 and are interconnected (shorted) at the opposite ends by a line or short 88.

A row (gate) line or bus 90 connects the subpixels 74 and 76 and all other row subpixel pairs in one-half of each of the pixels to a row (gate) pad 92. A second row (gate) line or bus 94 connects the subpixels 78 and 80 and all other row subpixel pairs in one-half of each of the pixels to the row pad 92. The bus lines 90 and 94 are interconnected (shorted) at or before the pad 92 and are interconnected (shorted) at the opposite ends by a line or short 96.

In a like manner, each of the other subpixel pairs are connected in columns to respective column (source) pads 98 and 100, etc. The pads 84, 98 and 100 are illustrated as being an opposite sides of the display to provide additional connecting space for the pads, however, they also could all be on one side as in the display 10. Each of the other subpixel pairs also are connected in rows to respective row (gate) pads 102 and 104, etc.

The pixel 72 then is divided into four subpixels 74, 76, 78 and 80 which allows for one of the subpixels to be defective, such as the subpixel 74, without causing a fatal defect, since the remaining three subpixels 76, 78 and 80 remain operative. In prior devices, the pixel 72 would be totally defective and hence the display 70 would be inoperable.

Further, one often fatal display defect is caused by a defect or open in one of the row or column bus lines which would cause the whole row or column to be out, again resulting in an inoperative display 70. With the respective subpixels pairs of row and column bus lines interconnected, however, an open in a bus line will at most cause one subpixel to be inoperative. An open in one or more of the bus lines between the subpixels will result in no defects, since the current is supplied from the opposite shorted end of the row or column bus line. Thus, the display 70 in effect has redundant row and column bus lines.

To avoid the fatal defect of the multiple open lines, as also disclosed in U.S. Ser. No. 948,224, the redundant row and column bus lines can be further interconnected at each subpixel. Each pair of the column bus lines 82 and 86 are additionally interconnected between each of the subpixels 74, 78, etc. by respective lines or shorts. In a like manner, each pair of the row bus lines 90 and 94 are interconnected between each of the subpixels 74, 76, etc. by respective lines or shorts. Further, although both the row bus lines and the column bus lines can be interconnected between each subpixel, only one of the row or the column bus line sets might be shorted to limit the loss of active pixel display area.

The short 69 in one of the active devices in the display 70 can be eliminated by opening the row or column line between the short and the line. This results in only one subpixel, such as the subpixel 74 being defective and due to the small size of the subpixel, is not a fatal defect (i.e. not readily visual). The rest of the corresponding column and row subpixels would be operable due to the redundant and interconnected row and column bus lines.

Referring now to FIG. 5, a matrix display incorporating one embodiment of an internal ESD guard ring of the present invention is designated generally by the reference numeral 110. The matrix display 110 is illustrated having four pixels 112, 114, 116 and 118. The pixels, however, can be subdivided into numerous subpixel configurations such as two or four subpixels, two by four or six subpixels or in three subpixels for color display applications. Also, as previously stated for the

subpixel matrix display 70, the number of pixels can be of any number and configuration, square or rectangular.

A column (source) line or bus 120 connects the pixels 112 and 116 and all other pixels in the same column to a source contact pad 122 at one edge of the display 110. A source line 124 connects the pixels 114 and 118 to a source contact pad 126. In a like manner, a pair of row (gate) lines 128 and 130 connect respective pairs of pixels 112, 114 and 116, 118 in each row to respective gate pads 132 and 134.

Each pixel 112, 114, 116 and 118 includes a respective active element, such as transistors 136, 138, 140 and 142 which couple the pixels to the respective source lines 120 or 124 and gate lines 128 or 130. To prevent a large electrostatic potential discharging through one of the transistors 136, 138, 140 and 142, an internal ESD guard ring 144 is formed around the pixels 112, 114, 116 and 118. The guard ring 144 is illustrated as a closed ring, but could also be an open L or C-shaped line if the gate and source pads all are on one respective side of the display 110.

The ESD guard ring 144 also is coupled via respective transistors 146, 148, 150 and 152 to, the source and gate lines. The guard ring 144 will be coupled to the end of each source and gate line, so if the source and gate lines include pads at their opposite ends (not illustrated), then the guard ring 144 will include a further respective set of transistors 154, 156, 158 and 160.

The ESD guard ring 144 preferably is formed from a low resistance metal, such as an aluminum alloy. The transistors 146 through 160 can include a floating gate (not illustrated), no gate, or can include an oxide below to form a spark gap.

In operation, with the guard ring 144, a potential placed upon the source pads 122 will not short one of the transistors 136 or 140. Instead, the transistor 146 will turn on followed by the transistor 150, shorting the potential from the pad 122, via the line 120, the transistor 146, the guard ring 144, the transistor 150 and the line 128 to the pad 132. Thus, the guard ring 144 will not allow high potentials across the pads 122, 126, 132 and 134. The guard ring 144 preferably is formed concurrently with the display elements and is not removed, providing continuous protection even following manufacture of the display 110.

A specific subpixel display incorporating an internal guard ring of the invention is best illustrated in FIG. 6 and is designated generally by the reference numeral 162. The display 162 includes a plurality of pixels, each having four subpixels in a similar fashion to the display 70 illustrated in FIG. 4. Only one pixel 164 is illustrated in detail and includes four subpixels 166, 168, 170 and 172. A source line 174 includes a shorting line 176 which is connected to a pair of source lines 178 and 180, coupled to each of the subpixels by a respective transistor structure 182, 184, 186 and 188, which are not described in detail. The transistors 182, 184, 186 and 188 also couple the subpixels 166, 168, 170 and 172 to a gate line 190.

An internal ESD guard ring 192 is coupled via a transistor structure 194 to the source line 174 and via a transistor structure 196 to the gate line 190. The guard ring 192 and transistors 194 and 196 operate as before described to short any potential to ground. The low value of the normal operating voltages does not turn on the transistors 194 and 196, which do not effect the normal display operation.

The ESD preventive structure can also include an outer ESD guard ring 200, best illustrated in FIG. 7. Only one corner portion 202 of the display and guard ring 200 is illustrated. While the display is being manufactured, the outer guard ring 200 is connected to all of one of the source and gate pads (not illustrated), which pads are serially connected together via jumpers outside of scribe lines 204 and 206. A corner pad 208 is connected to each other corner pad (not illustrated) by respective outer conductive lines 210 and 212 of the guard ring 200. The L-shaped corner pad 208 can be grounded and also provides the alignment for the scribe lines 204 and 206, which are utilized to disconnect the source and gate jumpers and the guard ring 200 after the structure is completed. The corner portion 202 includes a triangular pad 214 which provides alignment for diagonal corner displays, when utilized.

A backplane pickup contact pad 216 also is provided, which includes a corner 218 for aligning the backplane with the front plane. The pad 216 includes a shunt line 220 which is connected to one set of source or gate lines via a shunt transistor 222 along the edge to be scribed and removed along the line 206. The line 210 is connected to the other set of gate or source lines by a shunt line 224, a shunt transistor 226 and a large resistance 228, such as 100 K ohms (illustrated schematically). The outer ESD guard ring 200 provides ESD protection only during manufacture of the display and is removed prior to completion of the display. The resistance 228 provides an ESD short for high electrostatic potentials, which can be incurred during manufacturing of the display which can be connected anywhere between the line 210 and the other set of gate or source lines. The resistance 228 minimizes the discharge current surge and the shunt transistors 222 and 226 act as before described. There will be at least one corner backplane pickup pad 216 and preferably there will be two or three, each with their associated shunt transistors.

The outer guard ring lines 210 and 212 preferably are formed at the same time as the firs: of the gate or source lines. The inner guard ring 44 and the associated shunt transistors of both guard rings preferably are formed concurrently with the other display structures. The scribe lines 204 and 206 can be prescribed, but left intact until the back and front planes are mated and then removed to provide the gate and source contacts for the printed circuit board connections.

Modification and variations of the present invention are possible in light of the above teachings. The transistors 22 or other types of two or three terminal switching devices can be utilized with the invention. The amorphous silicon alloy semiconductor material 54, could be any of numerous types of materials such as CdSe or GaAs materials. The ESD guard rings can be utilized separately or together with all types of active element matrix displays and not just those illustrated. The shunt transistors 146, 194 and 222, etc. also can be formed as other active switching elements, such as diodes. It is therefore to be understood that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described.

What is claimed and desired to be secured by Letters Patent of the United States is:

1. A method of manufacturing active matrix display backplanes and displays therefrom, comprising:

providing a substrate;

forming a pattern of pixels on said substrate;

forming a plurality of row and column intersecting pixel activation lines, interconnecting substantially all of said row lines to one another and substantially all of said column lines to one another;

forming an outer electrostatic discharge guard ring on said substrate coupled to said interconnected row and column lines via a resistance to provide protection from electrostatic discharges between said row and column activation lines during manufacture of the displays; and

removing said outer guard ring and row and column interconnections prior to completion of the display.

2. The method as defined in claim 1 including coupling one plurality of said interconnected row and column lines to said outer guard ring via said resistance.

3. The method as defined in claim 2 including forming at least one pickup pad coupled to said resistance via a shunt switching element.

4. The method as defined in claim 3 including coupling said pickup pad to the other plurality of said interconnected row and column lines via another shunt switching element.

5. The method as defined in claim 3 including forming a corner on said pad to align the front plane and back plane of the display.

6. The method as defined in claim 3 including forming a plurality of pickup pads, each one on a separate corner of the display.

7. The method as defined in claim 1 including forming a corner pad on at least one corner of the display and aligning scribe lines with said corner pad for removing said outer guard ring and row and column intersections.

8. The method as defined in claim 1 including forming an inner electrostatic discharge guard ring on said substrate coupled to said row and column lines via shunt switching elements to provide protection from electrostatic discharges between said row and column activation lines during manufacture of the displays and thereafter.

9. The method as defined in claim 8 including forming separate shunt switching elements between said inner guard ring and each row and column line.

10. A method of manufacturing active matrix display backplanes and displays therefrom, comprising:

providing a substrate;

forming a pattern of pixels on said substrate;

forming a plurality of row and column intersecting pixel activation lines; and

forming an inner electrostatic discharge guard ring on said substrate coupled to said row and column lines via shunt switching elements to provide protection from electrostatic discharges between said row and column activation lines during manufacture of the displays and thereafter.

11. The method as defined in claim 10 including forming separate shunt switching elements between said inner guard ring and each row and column line.

12. The method as defined in claim 10 including interconnecting substantially all of said row lines to one another and substantially all of said column lines to one another and forming an outer electrostatic discharge guard ring on said substrate coupled to said interconnected row and column lines via a resistance to provide protection from electrostatic discharges between said row and column activation lines during manufacture of the displays; and

removing said outer guard ring and row and column interconnections prior to completion of the display.

13. The method as defined in claim 12 including coupling one plurality of said interconnected row and column lines to said outer guard ring via said resistance.

14. The method as defined in claim 13 including forming at least one pickup pad coupled to said resistance via a shunt switching element.

15. The method as defined in claim 14 including coupling said pickup pad to the other plurality of said interconnected row and column lines via another shunt switching element.

16. The method as defined in claim 14 including forming a corner on said pad to align the front plane and back plane of the display.

17. The method as defined in claim 10 including forming a plurality of pickup pads, each one on a separate corner of the display.

18. The method as defined in claim 10 including forming a corner pad on at least one corner of the display and aligning scribe lines with said corner pad for removing said outer guard ring and row and column intersections.

19. An active matrix display backplane, comprising:

a substrate;

a pattern of pixels formed on said substrate;

a plurality of row and column intersecting pixel activation lines, substantially all of said row lines interconnected to one another and substantially all of said column lines interconnected to one another; and

an outer removable electrostatic discharge guard ring formed on said substrate coupled to said interconnected row and column lines via a resistance to provide protection from electrostatic discharges between said row and column activation lines during manufacture of the displays.

20. The backplane as defined in claim 19 including one plurality of said interconnected row and column lines coupled to said outer guard ring via said resistance.

21. The backplane as defined in claim 20 including at least one pickup pad coupled to said resistance via a shunt switching element.

22. The backplane as defined in claim 21 including said pickup pad coupled to the other plurality of said interconnected row and column lines via another shunt switching element.

23. The backplane as defined in claim 21 including a corner formed on said pad to align the front plane and back plane of the display.

24. The backplane as defined in claim 21 including a plurality of pickup pads, each one formed on a separate corner of the display.

25. The backplane as defined in claim 19 including a corner pad formed on at least one corner of the display and having scribe lines aligned with said corner pad for removing said outer guard ring and row and column intersections.

26. The backplane as defined in claim 19 including an inner electrostatic discharge guard ring formed on said substrate coupled to said row and column lines via shunt switching elements to provide protection from electrostatic discharges between said row and column activation lines during manufacture of the displays and thereafter.

27. The backplane as defined in claim 26 including separate shunt switching elements formed between said inner guard ring and each row and column line.

28. An active matrix display backplane, comprising:

a substrate;

a pattern of pixels formed on said substrate;

a plurality of row and column intersecting pixel activation lines; and

an inner electrostatic discharge guard ring formed on said substrate coupled to said row and column lines via shunt switching elements to provide protection from electrostatic discharges between said row and column activation lines during manufacture of the displays and thereafter.

29. The backplane as defined in claim 28 including separate shunt switching elements formed between said inner guard ring and each row and column line.

30. The backplane as defined in claim 28 including substantially all of said row lines interconnected to one another and substantially all of said column lines interconnected to one another and an outer electrostatic discharge guard ring formed on said substrate coupled to said interconnected row and column lines via a resistance to provide protection from electrostatic discharges between said row and column activation lines during manufacture of the displays.

31. The backplane as defined in claim 30 including one plurality of said interconnected row and column lines coupled to said outer guard ring via said resistance.

32. The backplane as defined in claim 31 including at least one pickup pad coupled to said resistance via a shunt switching element.

33. The backplane as defined in claim 32 including said pickup pad coupled to the other plurality of said interconnected row and column lines via another shunt switching element.

34. The backplane as defined in claim 32 including a corner formed on said pad to align the front plane and back plane of the display.

35. The backplane as defined in claim 28 including a plurality of pickup pads, each one formed on a separate corner of the display.

36. The backplane as defined in claim 28 including a corner pad formed on at least one corner of the display and having scribe lines aligned with said corner pad for removing said outer guard ring and row and column intersections.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 5,019,002

DATED : May 28, 1991

INVENTOR(S) : Scott H. Holmberg

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Col. 2, lines 30-31, change "4,676,761" to --4,820,222--;

Col. 4, line 15, change "materially" to --material by--;

Col. 5, line 53, change "30" to --80--;
line 59, change "aI1" to --all--;

Col. 7, line 23, delete the third comma;

Col. 8, line 41, change "firs:" to --first--.

Signed and Sealed this

Twenty-third Day of February, 1993

Attest:

STEPHEN G. KUNIN

Attesting Officer

Acting Commissioner of Patents and Trademarks

[redacted]